The Cannon-Bone of Ruminants.—The usually accepted view has been that the cannon-bone of the hind leg of the ruminants consists of the coalesced metatarsals three and four, and that the metatarsals two and five become lost during development. J. E. V. Boas now offers evidence[5] which goes far to show that in these forms we are to recognize besides the coalesced metatarsalia three and four the upper ends of metatarsalia two and five. His views are thus in correspondence with those arrived at by various authors in the fossil forms.

EMBRYOLOGY.[1]

Embryology of Limulus.—Professor J. S. Kingsley publishes a preliminary note on the "Ontogeny of Limulus."[2] The segmentation nucleus undergoes several divisions before any signs of segmentation of the egg are seen at the surface. The resulting nuclei migrate towards the surface, and forty hours after impregnation the egg itself begins to cleave, so that the whole becomes separated into cells, with a nucleus in each segment, and a blastoderm forms on one side of the egg. Here the cells are smaller, forming a primitive cumulus, comparable to that of spiders. A circular spot appears in the center of the cumulus, becomes triangular, elongates, and forms a shallow groove,—the blastopore. The mesoderm forms along its margins. Later six pairs of segmentally arranged sensory thickenings appear outside the legs. The first pair gives rise in the median ocelli, the second to a new sense organ, the third disappears, the fourth remains as the "dorsal organ," the fifth gives rise to the paired compound eyes, the sixth is evanescent. All of these organs are connected by a longitudinal nerve. The facts obtained from the ontogeny point to a close relationship between Arachnids and Limulus.

Embryology of Phalangium. — A preliminary note on the early stages of Phalangium is published by Victor Faussek.[3] The egg breaks up into a solid mass of cells, each filled with yolk, and each containing a nucleus. From the large, superficial cells there separates by *delamination* small cells, while the resulting small cells form the blastoderm, which soon appears on one side of the egg. The large

[5] *Morph. Jahrbuch.*, XVI., p. 526, 1890.

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md.

[2] *Zoologisches Anzeiger*, No. 345, 1890.

[3] *Zool. Anz.*, January, 1891, No. 353.

yolk-cells in the center of the egg have their nuclei undergo a process of fragmentation, increasing by direct development. The germ-cells (sexual cells) appear when there is but a single-layered blastoderm. A few of the blastoderm cells, which later form the sexual cells, enlarge and form a group of cells which push beneath the surface. The epithelium of the midgut forms from entoderm cells. The nuclei of the yolk-cells form many small nuclei, surrounded by a quantity of plasma lying between the yolk and mesoderm, and soon arrange themselves into the cylindrical epithelium of the midgut. The author points out the correspondence between the early stages of Phalangium and Limulus.

The Embryology of a Scorpion.—Malcolm Laurie publishes a paper under the above title.[4] The earliest stage observed had a small blastoderm at the surface of one end of the egg. This becomes several layered by a process resembling delamination. At a later stage there is a single outer row of cells over one end of the egg, and a thickened mass of cells beneath, some of which are migrating into the yolk. The presence of a primitive groove is doubtful. At the posterior end of the blastoderm there is formed a mass of hypoblast cells, and these may represent invaginated hypoblast. Later a layer of primitive hypoblast cells is to be found under the rest of the blastoderm, and seems to be simply "*split*" from the epiblast. Numerous cells migrate into the yolk. The mesoblast forms under the whole ventral plate from a multiplication of cells of the primitive hypoblast. The origin of the serous membrane and the amnion is described in detail. Cœlomic spaces form in the mesoblast of the segments, and the thoracic appendages contain portions of the cœlom. The coxal glands open at the base of the fifth appendages, and are at first a pair of simple tubes, opening exteriorly at one end and into the cœlom at the other. They seem to be homologous with nephridia. The lateral eyes are as Lankester and Bourne affirmed, monostichous. The central eyes arise by invagination. The stomodæum forms early; the proctodæum much later as a solid plug of cells. The gill-books are appendages comparable to the abdominal appendages of Limulus.

Development of the Fresh-Water Sponge.[5]—Dr. Otto Mass has studied the development from the egg of Spongilla. The first two segments are equal in size and structure, and similarly the 4, 8, and 16 segments, are all alike, giving similar reactions to staining reagents.

[4] *Quart. Jour. Micro. Sci.*, Vol. XXXI., Pt. II.

[5] *Zeit. f. wiss. Zool.*, Band 50, Heft 4.

There results a solid morula. Serial sections demonstrate that at one pole of the morula the cells sink inwards, while the peripheral cells grow over, enclosing a cavity within one end of the egg. Whether this process is a process of growth of cells around one pole of the egg, or whether we have here a process between epibolic and embolic gastrulation, cannot be definitely decided. The cells soon begin to differentiate into tissues, and only the inner ones retain the yolk spherules. The outer layer becomes columnar ciliated ectoderm. Those cells lining the enclosed cavity become flattened at several places, and push out into passages ending in ciliated chambers. Later these latter form the inhalent passages. The remaining cells filling the egg contain yolk, and are the so-called mesoderm cells. Some of these form needles, each needle the product of a single cell, and by their growth push out the ectoderm before them. These changes have taken place while the larva was within the sponge tissues; but it now becomes free and swims about with the pole containing the cavity directed *forwards*. The method of swimming described by Götte, with the pole containing the cavity directed upwards, is undoubtedly pathological. The larval life lasts about twelve hours,—never so long as twenty-four. The best observations on the method of fixation were made with the horizontal microscope. The larva fixes itself by the pole which was directed forwards in swimming,—that is, the end containing the gastric cavity. The cavity itself diminishes. The young sponge flattens to a crust. The high, cylindrical, ectodermal cells become more cubical, then flatten till their longest diameter is tangential to the surface. At first the cilia, one to each cell, were close together, but as the cells flatten they lie farther apart. The above process of fixation and flattening lasts about one-half to three-quarters of an hour. The ectoderm cells around the periphery of the young sponge begin to spread out over the support to which the sponge is fixed, and it takes place by the amœboid-like migrations of the peripheral ectoderm cells. The ectoderm is never thrown off, as Götte supposed, and it seems probable that owing to rough treatment of the embryos they lost their delicate ectoderm. After the fixation of the larva the ciliated chambers—evagination from the inner cavity—come nearer to the surface, fuse with the ectoderm, and form the inhalent orifices. The exhalent orifice originates through a secondary connection of the inner cavity with the outer world.

Descensus Testiculorum.—Under the above title Dr. Hermann Klaatsch, of Heidelberg, has given, in the *Morphologisches Jahrbuch*,

Dec. 16, 1890, what promises to be an important contribution to that most interesting *problema magnum.*

Regarding the recent work upon the actual ontogenetic changes taking place in the human embryo as insufficient for explaining the true morphological descent of the testis in the Mammalia, the author returns to the comparative methods of Hunter and others, and ultimately sees reasons for associating this change of position with changes in other organs,—namely, mammary glands.

From the position of reproductive glands, Wolffian body and body-wall in many mammals the gubernaculum is found to be a complex structure, not entirely homologous in different groups. Thus the testis is first attached to the Wolffian body; only later does the latter become connected with the body-wall by a special "inguinal ligament," which is connected with a peculiar inward process of the muscular body-wall, an "inguinal cone." The separateness of these three parts of a complex gubernaculum is shown in the adult Monotremes.

The phenomena occurring in the periodic descent in the rodents and insectivores furnish the starting point for the interpretation of all other groups.

Here the gubernaculum is chiefly a much-enlarged "inguinal cone," or modified ingrowth of transverse and internal oblique muscles (cremaster). *Pari passu* with the descent of the testis in the adult occurs the evagination of this cone to form a scrotal pouch. This descent appears to correspond to the period of enlargement of the testis; the withdrawal into the body to the period of enlargement of the mammary glands of the female.

In lemurs, apes, and man secondary changes have resulted in the occurrence of the descent once for all in the embryo. Even here the "inguinal cone," though not playing so important a part, in the single descent has muscles resembling those in the rodent. The preformation of a scrotum independent of the descent is not found in all these animals so markedly as in man, where it is to be regarded as a newly acquired falsification of the true record of sequences, and one that is here alone transferred to the female (in the form of the labia majora).

In man, again, an interesting exception to the lack of periodicity occurs,—a reminiscence of a previous adult rodent-like condition being represented by two successive descents in the embryo. Thus a temporary descent has already taken place in embryo of eight cm. This is followed by what is interpreted as a true reditus testium,

subsequent to which the permanent, commonly described descent takes place.

The anatomical relations in the marsupialia, carnivora and ungulates are to be regarded as indicating a separate line of divergence of these groups from the rodent-like conditions. The position of the scrotum is not really so aberrant in the marsupial as to interfere with close comparisons.

A preformed scrotum is here again to be regarded as a falsification of the phylogenetic history, associated with the permanent establishment of the descent in the embryonic period.

From numerous facts, of which I have given an imperfect survey above, the author establishes a connection between the mammary gland and the descent as follows:

The embryo rodent differs from the adult Monotreme in having the gubernacular "inguinal cone."

The descent is not found in the Monotremes and lower vertebrates, and must have arisen in higher mammals.

In these the descent is associated with the modification of the belly-wall, the "inguinal cone." In seeking a cause for the production of this modification of the belly-wall, some external factor and not internal organs is to be considered.

This external factor in the modification of the muscular body-wall was a mammary gland.

The simplest mammary gland is the small area of skin glands with well-developed skin muscles in the inguinal region, on each side, in the Monotremes. This is present in the male also, but is to be considered as secondarily derived from the female.

That such a body might react upon the body-wall is indicated by the existence of the cremaster muscles in the female marsupial, gland and muscle functioning together. Some such change in connection with a mammary gland may have formed the "inguinal cone."

This cone in the male was utilized as being the point of least resistance in the body-wall, and evaginated when the testes enlarged periodically. Though such a cone is present in female animals, it is not associated with the ovary, as this does not enlarge.

The origin of the inguinal ligament remains unexplained, but this also may have been handed over from the female, with other organs connected with the mammary gland.

Granting the scrotum represents such a primary mammary gland area, we would expect to find no true mammary glands in males.

Those present anterior to the inguinal region are easily explained as

recent acquisitions from new organs in the female; while the state of things in the marsupial strengthens the hypothesis. In the lowest Australian marsupial there are no glands in the male, but a scrotal pouch in the place of the female inguinal glands. In Monotremes there are male glands, but no scrotum as yet formed.

The discovery of remnants of such mammary glands in the area into which the testes descend would increase the value of the hypothesis. Such are present in all groups of mammals, conspicuous in apes, and even found in man, in embryos.

The "area scroti" are warty, circumscribed regions of the scrotum, one on each side, in which peculiarities of skin glands, hairs, and especially of skin muscle, form strong contrasts to the rest of the scrotal skin.

These "area scroti" are the externally visible outlines of these primitive mammary organs that gave rise to the descent of the testes.

On the Urinogenital System of the Crocodile and Turtle.[6] —1. There is an undoubted trace of a pronephros in embryos of both, which soon degenerates. 2. A very large glomerulus hanging into the body-cavity on either side. Often the nephrostomes of the pronephros are close to its sides. 3. A segmental arrangement could not be made out for pronephros or glomerulus; no very young embryos were examined. 4. The boundary between pronephros and mesonephros could not be made out, and it was not possible to count the number of nephrostomes belonging to either. 5. The origin of the pronephros—whether from ectoderm or mesoderm—could not be determined. 6. Nephrostomes of the mesonephros often become partially or wholly separated from the body-cavity by a growth upward of the lower lip of the funnel, which surrounds the glomerulus above it. 7. The Müllerian duct is formed entirely independently of the segmental duct, by a folding of the peritoneal ephithelium anteriorly, constricting off the proximal end of the duct, which then grows backwards to the cloaca as a solid rod of cells, which soon acquires a lumen. —J. L. KELLOGG.

The Development of Cyanea arctica.—Since the publication by Louis Agassiz of the third volume of his "Contributions to the Natural History of the United States" no observations have been recorded upon the development of *Cyanea arctica.* During the month of May of the past summer this Medusa was exceedingly abundant in Vineyard Sound and the adjacent waters, and on my arrival at the

[6] R. Weidersheim. *Arch. f. Mik. Anat.*, Band 36, Heft 3, 1890.

Marine Biological Laboratory at Woods Holl, towards the end of that month, I had no difficulty in obtaining large quantities of ova in the earliest stages of development, and I succeeded in keeping the embryos alive until the end of August, by which time they had developed into Scyphistomas with about twenty tentacles.

The developmental history as I observed it differs in so many points from what Agassiz has described, as well as from the observations of other authors upon European forms, that I wish to postpone a detailed account of my observations until I shall have had an opportunity of studying for comparison the embryology of *Aurelia flavidula,* which I hope to accomplish during the coming summer. In the meantime I wish to record here briefly some of the more important facts which I have been able to establish.

The segmentation is practically regular (though the relative size of the first-formed spherules *may,* vary considerably), and results in the formation of a blastula. Certain cells then migrate into the blastocœle, and arrange themselves as an incomplete layer below the cells which remain at the surface, and at the same time an opening appears at one pole of the embryo. This pseudogastrula is, however, very transient. The immigration of cells continues, being apparently multipolar in its distribution, and the opening closes up. Eventually a solid planula or sterrula results, consisting of an external layer of columnar cells and a central mass in which the cell outlines cannot be made out in sections.

In this condition the embryos may persist for some time, swimming about actively. From time to time, however, some settle down to the bottom of the vessel in which they are contained, and enclose themselves in a circular plano-convex cyst. I found a few free-swimming embryos, out of the many hundred which I examined, which had developed a mouth and a central cavity, and possessed a rudiment of a single tentacle, but their further development I was not able to observe. It is certain that the majority encysted themselves in the manner described, but it is of course possible that this may be due to unsatisfactory conditions of life, though the fact that large numbers of the encysted form developed into Scyphistomas argues against such an idea.

While within the cyst, the hollowing out of the central mass and the formation of the endoderm take place. The encysted state lasts for several days, but finally the embryo emerges from the cyst through a circular aperture in the center of the free convex surface of the cyst, formed apparently by solution, as I never saw any ragged edges to the opening. I could not at first believe that the encystment was a stage in the development; it seemed rather to mean the death of the embryos.

The fact that every young Scyphistoma was attached to a cyst, its stalk passing through the opening and spreading out on the lower flat wall, first aroused my suspicions, and I finally succeeded in observing the embryos leaving the cyst, and have sections through forms in various stages of emergence. Encystment has been observed by Kowalewsky in Lucernaria, but was supposed to be a precursor of death. No one has yet observed what I have mentioned above in any Scyphomedusa, but my preparations do not allow of any doubt as to its existence in *C. arctica.*

Shortly after their emergence from the cyst the mouth forms, placing the internal cavity in communication with the exterior, and four tentacles make their appearance. I could not detect any invagination to form the mouth, such as Claus, and especially Goette, have described for other Scyphomedusæ. My preparations show that the ectoderm and endoderm come into contact at the margin of the mouth opening, and that there is no stomatodæal invagination of ectoderm such as Goette maintains exists in Cotylorhiza and Aurelia. It is to be noticed that a similar absence of an ectodermal stomatodæum occurs in *Lipkea ruspoliana,* described by Vogt as the representative of a new tribe of sessile Medusæ, but which, it seems probable, is simply a Scyphistoma.

With regard to the formation of the mesenteries of the Scyphistoma, my results are quite at variance with those of Goette. The young Scyphistomas with four tentacles show no signs of them; in older specimens with the same number of tentacles traces of them are occasionally to be found; but as a rule they are not formed till the young larva has acquired eight tentacles. It is unnecessary to state that in *Cyanea arctica* their formation stands in no connection with the formation of an ectodermal stomatodæum, since this structure does not exist.

An account of the structure of the mesenteries, and the formation of the "trichter" and of the mesenterial filaments, will be given in the complete paper.—J. PLAYFAIR McMURRICH, *Clark University, Worcester, Mass.*